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Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, Grand Buildings, Trafalgar Square, London, S.W. 1, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE IMPERIAL AGRICULTURAL BUREAUX.

SIR DAVID CHADWICK in an article published recently in *Chemistry and Industry** clearly explains the organisation and objects of the Imperial Agricultural Bureaux. These bureaux, by collecting and disseminating scientific information likely to be useful in connection with agriculture, are of great help to scientific workers throughout the Empire and other parts of the world. We feel, therefore, that attention should be drawn to their work and cannot do better, in this instance, than quote extensively from Sir David's article. "During the last thirty years," he says "there has been an ever closer association of science with agriculture in the various parts of the British Commonwealth of Nations. Few know the details; all approve of development; many press for more. In greater or less degree similar development has occurred in nearly every foreign country."

"A farmer is often one man, the heir of much accumulated knowledge. In contrast the application of science to agriculture calls for a whole battalion of experts—the chemist and entomologist, the geneticist and geologist, the physiologist and helminthologist, &c. The chief interest of a research institute may be fruit or dairy products or animal health or what you will. The professional designation of each member of their staffs will end in 'ist,' but preceding that ultimate 'ist' will be a whole variety of syllables denoting different sciences. It is in these two facts—the great development in most countries in the application of science to the problems of agriculture, livestock, and forestry and the range of sciences whose aid has to be sought that the reason for the Imperial Agricultural Bureaux is found."

"The number of scientific journals in the world is immense. The circulation of reprints of papers among scientists is generous. Yet few are the research stations which can maintain libraries fully adequate for each one of its specialists. Even where this may be done, limitations of time and language check its fullest use. The systematic collection, preparation, and circulation of abstracts may be deplored but few who wish to be abreast of the times in their own subject and have once used them cease to do so. There is surely something to be said for a system which

* *Chemistry and Industry*; Vol. 60, No. 21, 1941.

causes a plant geneticist in Mauritius to write to Cambridge saying 'Please send me at once an English translation of a paper by a certain Dutch scientist at work on sugar cane in Java the notice of which is contained in *Plant Breeding Abstracts* just received. I was just about to lay down a series of experiments and his paper may save me a season's work.' " . . .

"The motto of the Imperial Agricultural Bureaux is service to scientific research workers. The interpretation to the farmer of the results of science is for the Ministries, the Departments, the Agricultural Societies in the several countries. The choice of problems for investigation lies with the scientist and research institute in each country. The bureaux by doing their best to obtain promptly and regularly all the literature in their various subjects, index it, abstract it, and make those abstracts regularly available, save the time of the scientist and strengthen his attack on his chosen problem. No one would claim that nothing is ever missed. Nor is every paper published deemed worthy of abstract. There is much repetition in scientific and still more in quasi-scientific literature. But service improves with practice and a good regular abstract journal is itself a magnet attracting information."

"Just as any research institute comprises different specialists in different branches of science associated together but each branch with its own laboratory, so the bureaux form an associated group but each with its own particular interest and its own location. Each is placed at a research institute of high repute in the subject of the bureau; thus the Imperial Bureau of Soils and Fertilizers is located at Rothamsted, that for Plant Genetics at Cambridge, . . . and so forth. The officers in a bureau profit by opportunities to meet easily both resident scientists engaged in research in its subject and those from other research institutes who naturally visit that institute."

"The Director of a Research Institute is usually the Director of the Bureau located there. Yet the Bureau is not part of the Institute. The Director of an Institute in his capacity as Director of a Bureau has general supervision over the bureau and, in his subject, is the chief scientific adviser to the Executive Council of the Imperial Agricultural Bureaux, *i.e.* to the body which administers all the bureaux. The chief operating officer in the bureau is usually the Deputy Director. He is a specialist in his own subject, full time on bureau work, appointed, paid, and controlled by the Executive Council of the Bureaux. In addition to his science he usually knows several foreign languages and has on his staff others trained in his subject and knowing other languages."

"The general plan on which the bureaux work is similar and many general administrative directions, *e.g.* distribution of free copies of publications, are the same for all, but flexibility is the rule not rigidity. This is fostered by the bureaux being at research institutes where scientists in that subject congregate. Thus each develops types of service desired by the specialists in its subject."

"Visits of bureaux officers abroad are fostered where possible. They are obviously desirable. But they are costly in time and money, certainly to countries in the further parts of the British Commonwealth of Nations. They have not been as general as could be wished. But each bureau has in each of those countries its own Official Correspondent. He is a specialist in his own subject nominated by its Government. His function briefly is to be 'the general friend' of the bureau in that country, to be turned to in any difficulty, to be consulted when necessary on any suggestion or line of work, to make suggestions. Correspondence, however, is not canalized either through the Executive Council or through this Official Correspondent. On scientific and technical subjects each bureau corresponds freely and directly with scientists in any country."

"Many a specialist may know one of the bureaux but does not realize that it is one of a number working cooperatively together. The bureaux—the two oldest are styled Institutes—number twelve. They are (omitting for the moment their common pre-nomen 'Imperial') Institute of Entomology, Mycological Institute, Bureau of Soil Science, Bureau of Animal Health, Bureau of Animal Nutrition, Bureau of Animal Breeding and Genetics, Bureau of Plant Breeding and Genetics, Bureau of Pastures and Forage Crops, Bureau of Horticulture and Plantation Crops, Bureau of Agricultural Parasitology (Helminthology), Bureau of Dairy Science, and Bureau of Forestry."

"Science recognizes no strict confines in its application. Many problems of animal nutrition are the same as those for human nutrition; entomology, veterinary, helminthology have their medical aspects. Several bureaux serve scientists the practical application of whose work is other than agriculture.

"The work of the bureaux is not confined to the issue of abstract journals. The two Institutes have for years aided in the identification of species and specimens. That of Entomology presents each year up to 20,000 type specimens—many entirely new to science—to the British Museum (Natural History). Dr. Neave (Entomology) with the assistance of the Royal Zoological Society has recently issued 'Nomenclator Zoologicus' (4 Vols.), a complete and fully referenced catalogue of names used in the animal and insect world. The Mycological Institute has a large stock of herbarium specimens, many of them first types. These two institutes are therefore specially interesting to systematists. Also, as Technical or Occasional Communications, each bureau issues from time to time reviews of information (with bibliographies) on particular subjects. Examples are those on Erosion and Soil Conservation, Vernalization, Field Trials, their Lay Out and Statistical Analysis. Over a hundred such have been published. Regular Bibliographies of current scientific literature, *e.g.* 'Index Veterinarius,' is another form of service."

"All publications can be obtained through booksellers. Those on entomology, mycology, and human and animal nutrition also direct from the appropriate Institute or bureau and those of all other bureaux direct from the Central Sales Branch of the Imperial Agricultural Bureaux, Agricultural Research Building, Penglais, Aberystwyth, Wales, which will in addition supply information about the publications of any of the Institutes or bureaux."

"But why 'Imperial' in their title? Do they presume to dominate the field of science? Nothing is further from the truth. They seek to serve the scientist. But it was the governments of the British Commonwealth of Nations who got together to provide, primarily for their own scientists, this regular organized service of information. Those governments supply the funds in agreed proportions and prescribe the broad lines of administrative control. This control is exercised by an Executive Council on which each of these co-operating governments has one member. The wide official support thus secured ensures continuity of their service. War has temporarily broken many links in Europe. But scientists elsewhere still turn to the bureaux. The use made of them was increasing each year and had not reached its limits. All who could use them with advantage to themselves do not yet do so. The greater the use made of their services, the more information they gather and more useful is the service they can render."

OBITUARIES.

Sir ARTHUR HILL, K.C.M.G., SC.D., F.R.S.

We much regret to announce the death of Sir Arthur William Hill, Director of the Royal Botanic Gardens at Kew, who was killed in a riding accident on the Mid-Surrey golf course on 3rd November.

Sir Arthur had a distinguished career. Educated at Marlborough and King's College, Cambridge, he was in 1899 appointed University Demonstrator in botany and from 1905 to 1907 was Lecturer in Botany. He had been elected a Fellow of King's in 1901, became Dean in 1907, and since 1932 had been an honorary Fellow. From 1907 to 1922 he was Assistant Director of the Royal Botanic Gardens, Kew, and since 1922 had been Director.

Sir Arthur's association with the College dates back to 1922 when he was nominated by the Secretary of State, then Mr. Churchill, to be one of his representatives on our Governing Body. To this appointment he brought the conscientious thoroughness which marked all his activities, and in his capacity as Governor rendered most valuable services. In 1924 he made the long voyage from England to Trinidad to attend the laying of the foundation stone of the new College building, and went on to attend the Ninth West Indian Agricultural Conference in Jamaica. A little later he was closely associated with the planning and launching of the Banana Research Scheme, and after that took a similar lively interest in the Cacao Research Scheme. There has, indeed, been no major College work within the wide scope of botany in which Sir Arthur Hill has not given advice, support, and willing assistance. Members of the staff, on leave, were always kindly welcomed at Kew, and found the Director in spite of his many occupations, very well informed about College affairs and progress.

This friendly attitude towards the College was only one aspect of Hill's real desire that Kew should be useful to the whole of the British Commonwealth, and not least to the Colonial Empire. He had personal knowledge of many lands; as under the auspices of the Empire Marketing Board he was at one time able to travel extensively, visiting Australia, New Zealand, Malaya, South Africa and East Africa, and he also visited South America, the West Indies, Canada, the United States and India. In all those journeys he developed and extended links between Kew and botanical institutions overseas, and in the Colonies particularly he encouraged Agricultural Departments to call on Kew for any possible assistance. Writing in Trinidad, we omit to mention Sir Arthur's great interest in the preparation of the Flora of Trinidad and Tobago, to which he had consistently given support from its inception. At the time of his death he had recently finished the treatment of certain families himself, and amid all his war time preoccupations expressed his readiness to take on more.

Sir Arthur's loss will be keenly felt throughout the Colonial Empire where he had made many friends.

* * *

Mr. MARK RADFORD CUKE.

It is with deep regret that we received the news of the death, on 24th November, in England, as a result of a flying accident, of Mr. Mark Radford Cuke. Mr. Cuke who was educated at Harrison College, Barbados, joined the Imperial College of Tropical Agriculture as a Diploma student in October 1937. In June 1940, after successfully completing his studies, he was awarded the Diploma in Sugar Technology. He was due to return to the College in October 1940 to continue his training in sugar technology but instead joined the Royal Air Force and obtained his "wings" in August 1941.

Mr. Cuke's record at the College was an excellent one. He was a most promising student and popular both with his fellow students and the staff. In the laboratory as in the factory he did his work with the quiet enthusiasm that was so characteristic of him. He was quick to grasp essential principles and he had the initiative and personality to be able to apply them on the job. Our deepest sympathy goes to his family in the irreparable loss which they have sustained.

PLANTATION CACAO IN THE BRITISH CAMEROONS.

By J. West and O. J. Voelcker,
(*Department of Agriculture, Nigeria*).

Introduction.

We are able to publish these observations on plantation cacao in the British Mandated Territory, Cameroons, as a consequence of unique opportunities. One of us (J.W.) was Supervisor of the former German owned plantations in 1940 and the other (O.J.V.) visited the Cameroons during this period to advise on cacao production. Our observations relate only to these former German plantations, since the few British plantations do not now cultivate cacao.

The Victoria and Kumba Divisions of the British Cameroons comprise an area of about 5,328 square miles, which is dominated by the Cameroons Mountain (13,350 ft.). Most of the former German plantations lie around the lower slopes of this mountain and along the Mungo and Meme Rivers to the east and north, respectively. These plantations have a total area of over 80,000 acres under cultivation, of which 22,445 acres are under young or old cacao grown either alone or interplanted with other crops.

Soils.

The soils of the Southern Cameroons have been described by Doyne, Hartley and Watson (1), and the following remarks are taken from their paper. Amongst the foot hills of the mountain, the soil is a red sandy loam which is derived from a deep horizon of broken up volcanic ash. This type of soil is found in Ekona, Molyko and Moliwe plantations (*see* map), around Victoria and along the west coast towards Idenau. In the latter area, the soil, though rich, is sometimes very shallow.

About two miles inland from Tiko, the land drops abruptly to the plain which runs out to the mangrove swamps along the lower reaches of the Mungo River. The soil is a dark brown heavy loam, occasionally showing concretions where drainage has been impeded or on the lighter land on the slopes where erosion has caused denudation. Much of this area is notable for the depth of the soil.

Around Kumba, the soils are heavy loams of a reddish tinge, and along the Meme River they gradually become more sandy towards the mangrove swamps which fringe the coast northwards from Idenau.

Generally speaking, the soils of the whole area represent a high degree of fertility, as is shown by the luxuriant growth of bananas in the plantations.

Rainfall.

The annual rainfall in the Southern Cameroons is heavy, as is shown by the following typical figures :—

Kumba	96 inches.
Missellele	91 ,,
Molyko	111 ,,
Buea	106 ,,
Victoria	157 ,,
Ngeme	161 ,,
Debundscha	380 ,,

The heaviest rainfall occurs at Debundscha, on the western side of the mountain (*see* map), and it decreases rapidly inland and at the lower elevations. At Kumba and on the Tiko Plain the dry season is well marked, and comparatively little rain falls during the period November to February. In the wetter areas the dry season is considerably shortened and during the months of June, July and August, monthly precipitations of over 30 inches are common. On the slopes of the mountain, though the rainfall may not be excessive the wet season is marked by seemingly perpetual mists, so that the hours of sunlight are strictly limited.

History of Cacao Cultivation.

The Germans opened up the first plantations towards the end of the last century, cacao being one of the main crops cultivated. Van Hall (2) states that these plantations exported 3,392 tons of cacao in 1912. Between 1916 and 1925, the plantations were administered by the British Government, after which most of them were repurchased by the German Companies. In September, 1939, the German plantations were again taken over by the British Government.

The cacao areas fall into three groups :—

(i) *The Original Cacao Farms Planted before* 1914.—Much of the cacao of these old areas was interplanted with oil palms or rubber. Where it was planted as a sole crop, no attempt was made to give it overhead shade. A considerable area survives today, although the poorly developed trees under rubber were being cut out by the Germans, and in the purely cacao areas there is a very high proportion of vacant stands. The living trees have large trunks, frequently moss covered, with, now, poorly developed tops. Each year a number die. Of late years no attempt was made by the Germans to supply or improve these areas, but the ground was kept cutlassed and the crop harvested.

(ii) *Cacao Farms Planted between* 1925 *and* 1930.—The Germans continued to follow their original practice when establishing these areas.

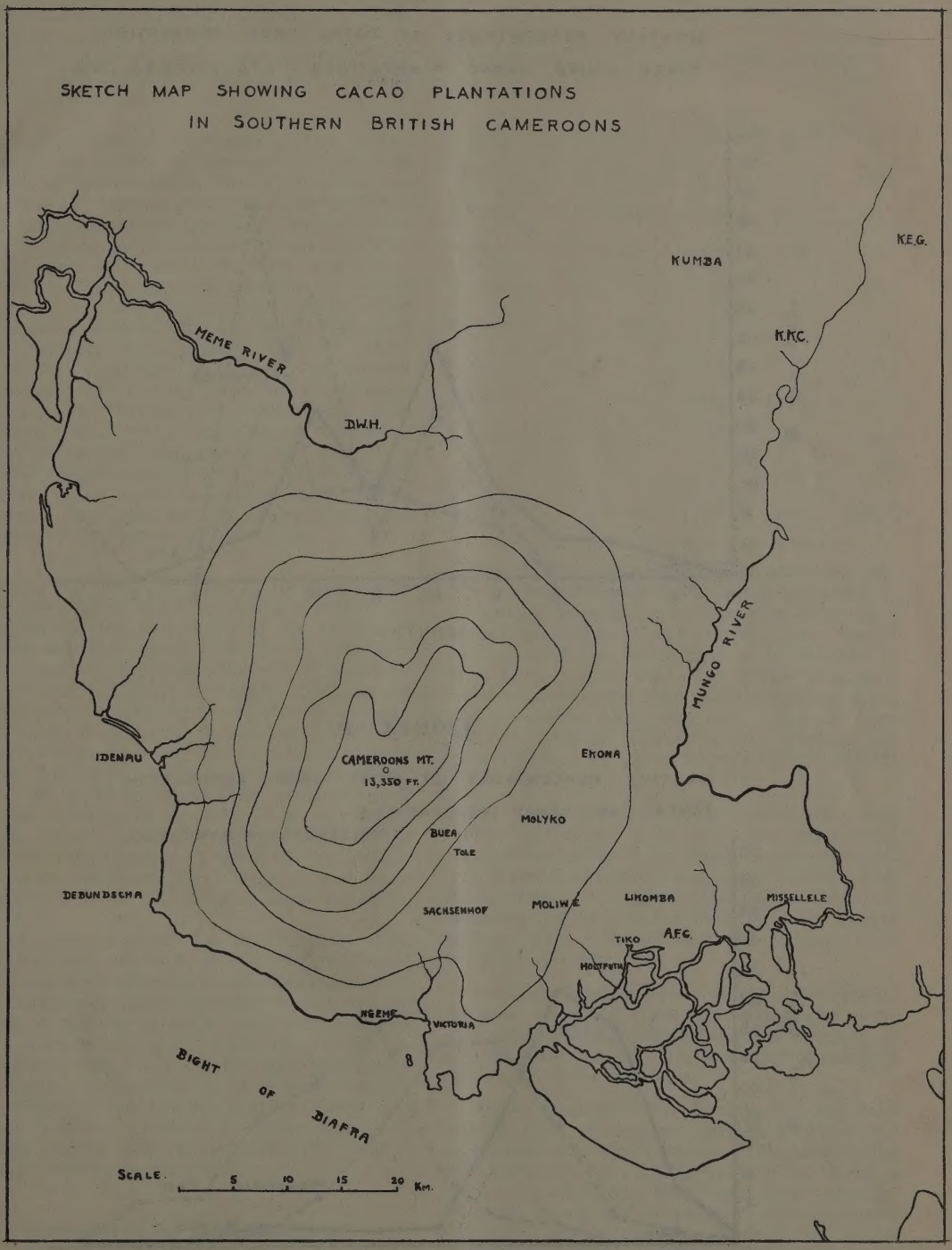

SKETCH MAP SHOWING CACAO PLANTATIONS
IN SOUTHERN BRITISH CAMEROONS
KUMBA
K.E.G.
K.K.C.
MEME RIVER
D.W.H.
MUNGO RIVER
IDENAU
CAMEROONS MT.
13,350 FT.
EKONA
MOLYKO
BUEA
TOLE
DEBUNDSCHA
SACHSENHOF
MOLIWE
LIKOMBA
MISSELLELE
TIKO
A.F.C.
HOLYFUTH
NGEMC
VICTORIA
BIGHT OF BIAFRA
SCALE.
5
10
15
20
KM.

FIGURE 1.

MONTHLY PERCENTAGES OF TOTAL CROP PRODUCTION.
THREE YOUNG CACAO PLANTATIONS – AFC, LIKOMBA, DWH.

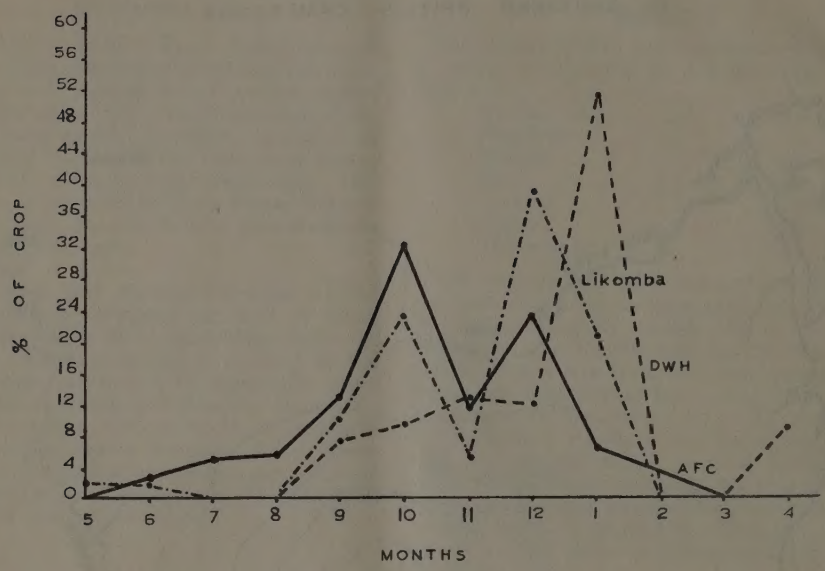
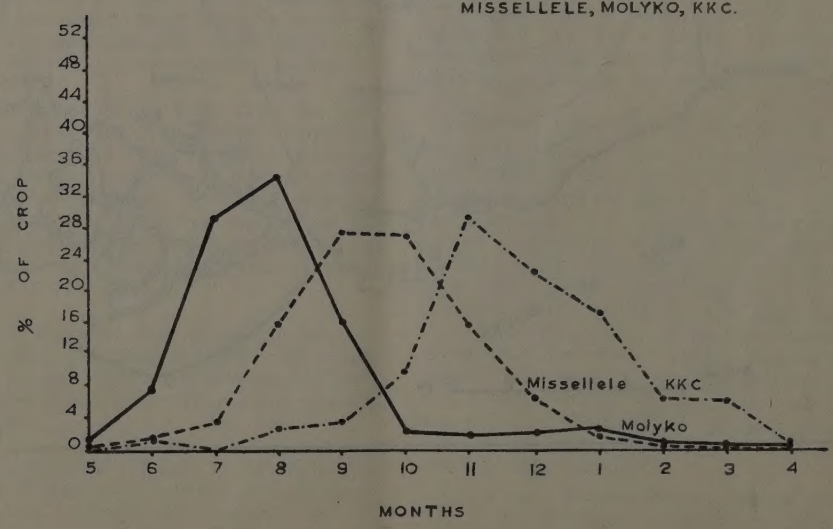


FIGURE 2.

MONTHLY PERCENTAGES OF TOTAL CROP PRODUCTION.
THREE OLD CACAO PLANTATIONS –
MISSELLELE, MOLYKO, KKC.



Seed was taken from local sources, and the cacao was planted either mixed with oil palms or rubber, or as a sole crop without any overhead protection. It was only in recent years that some plantations began to plant leguminous trees to give overhead shade for the cacao.

(iii) *Areas planted since* 1931.—After 1931 a change seems to have occurred in the policies of the different plantations. There was a quickening interest in the amazing profits to be derived from the expanding banana industry, and the low price for cacao, which appeared to have become normal, was not attractive. The older cacao growing plantations turned to oil palms and rubber as permanent crops, sometimes because they lacked forest land suitable for cacao. The chief cacao planting was generally done by those plantations primarily interested in banana production. The reasons given by the Germans were two-fold, firstly that instructions from Germany required the establishment of a prescribed amount of cacao, and secondly that when the land could no longer bear profitable banana crops the cacao would be allowed to develop in its place. This latter method results in delaying considerably the growth of the cacao.

Throughout most of Victoria Division, cacao gives the impression of not being suited to its environment. On the slopes of the mountain, it seems hardly to grow at all during the rainy season, and at this time may even defoliate. Die back of the twigs is common, but cannot generally be ascribed to insect attack, although Sahlbergella does appear periodically. With the advent of drier conditions the trees begin to grow and by the end of the dry season they are in full flush. To a lesser extent these remarks apply to cacao growing in the Tiko plain and in the Kumba district, although the young cacao of the AFC and the old cacao of the KKC are notable exceptions. Nowhere does the cacao look quite as healthy as in the best areas of Southern Nigeria.

In a previous paper (3) we described three types of cacao die back, due to drought, insect attack and unsuitable soil conditions respectively. Van Hall (*loc. cit.*, page 26) states that an average annual rainfall of 80 inches and over may not prove suitable for cacao. Since the soils of the mountain slopes, the Tiko plain and the Kumba district are fertile types, it is probable that the unthriftiness of cacao in the Southern Cameroons is due to the heavy rainfall of the wet season and possibly to the low temperatures and lack of sunlight which accompany it.

Description of the Cacao Plantations.

The larger cacao growing plantations are listed hereunder, with the ages of the areas under cultivation and the average annual production in tons prior to 1939.

AREAS IN ACRES PLANTED.

Plantation.	Prior to 1914.	1925-30.	1931-39.	Production in Tons.
WAPV ...	3,608	888	322	490
KKC ...	1,601	—	—	268
Ekona ...	1,505	150	221	255
Moliwe ...	2,256	607	1,359	187
Holtforth ...	875	375	—	45
Idenau ...	836	43	—	42
AFC ...	—	1,258	639	156
DWH ...	829	909	337	49
Likomba ...	—	170	1,441	35
KEG ...	—	—	2,216	28
Totals ...	11,510	4,400	6,535	1,555

The WAPV consists of three cacao sections; Ngeme near Victoria (now being converted to oil palms), Missellele near Tiko (now becoming a rubber plantation), and Molyko, the largest section, which lies below Buea at an elevation of from 1,300 to 2,000 feet. The WAPV also has a series of small farms, containing mixed old cacao and oil palms, along the road rising up from Victoria to Buea. Recent cacao planting had been restricted by a lack of forest land in suitable localities.

The KKC plantation near Kumba has only rubber and cacao. 1,274 acres are under cacao as a sole crop without any overhead protection and 327 acres are mixed cacao and rubber. This cacao looks more healthy than any of the other old areas and, as later described, gives the highest average yield. The elevation of this plantation is about 700 feet.

The cacao areas of Ekona plantation lie mostly between 1,200 and 1,300 feet, and at the upper end adjoin Molyko plantation. The majority of the trees are old, and are frequently mixed with tall palms of the same age.

Moliwe plantation lies among the foot hills behind Tiko. It deserves mention only because it represents the cult of mixed cultivation carried to absurdity. Only 13 per cent. of the cacao is grown as a sole crop. Many areas carry a mixture of cacao, rubber and oil palms of all ages and in all stages of development. A great deal of the crop produced was, moreover, Black cocoa.

Holtforth plantation at Tiko was a mixture of bananas and old cacao, the latter crop having recently been cut out. Idenau plantation, along

the west coast, had a fairly large acreage under old cacao. The trees were well grown, but the wet conditions there seemed to be unfavourable for real health, although it was claimed that the rainfall did not bring on heavy attacks of Black Pod disease.

The AFC, Likomba, DWH and KEG plantations are all primarily concerned with banana production and the young cacao is interplanted through the bananas. The young cacao of the AFC is the best looking of its age seen in the British Cameroons.

Methods of Cultivation.

The cacao was usually planted 4 meters by 4 meters. Where it had been interplanted with oil palms or rubber, the distance between the rows of cacao might be increased. Thus two or three rows of cacao would be planted between every two rows of rubber trees.

In spite of a high rainfall no particular attention was given to drainage. Sometimes main drains were laid out to take away storm water but the soils round the mountain are sufficiently porous to allow very rapid drainage, and the clearness of the streams even during the height of the rains is notable. In parts of the Tiko plain the cacao benefits from drains put in for the bananas, through which it was interplanted.

In the old cacao areas Elephant Grass dominates the vegetation which comes in wherever the overhead canopy has been broken. Frequent cutlassing was practised to keep this grass in check. A certain amount of pruning was done and sometimes the moss was scraped off the trunks of the trees. Where cacao was growing through bananas it "suffered" the deep hoeing which was considered necessary for the bananas three to five times each year; otherwise it received no attention beyond supplying.

Apart from a few experiments, no manuring of cacao was carried out.

Crop Delivery.

Van Hall (*loc. cit.* page 449) says that . . . . "the main crop comes in July and August, and an after-crop in November, December and January". Table I shows the percentage of the total crop produced during each month for nine of the plantations. These figures are of interest because they show that the time of main crop delivery is governed by the environment and the age of the cacao, which would explain Van Hall's statement.

In the Kumba district, the main crop of the KKC (old cacao) and DWH (50 per cent. young cacao) is strikingly confined to the months of November, December and January. In the

TABLE I.—CACAO: MONTHLY PERCENTAGES OF TOTAL CROP PRODUCTION.

Month.	Ngeme	Missellele.	AFC.	Holtforth.	Likomba.	Molyko.	Ekona.	KKC.	DWH.
May ...	1.7	0.2	—	—	1.5	1.4	—	—	—
June ...	7.2	1.4	2.3	—	1.2	7.8	—	1.1	—
July ...	13.4	3.5	4.7	2.6	—	29.7	18.2	—	—
August ...	22.8	15.9	5.3	15.4	—	34.7	55.1	2.3	—
September ...	18.4	27.7	12.6	11.3	9.9	16.1	13.0	3.5	7.2
October ...	16.1	27.1	31.9	18.0	22.7	2.1	12.5	9.9	9.1
November ...	12.4	15.9	11.0	18.8	5.2	1.9	—	29.6	12.4
December ...	5.7	6.3	23.1	23.8	38.7	2.0	1.2	22.6	11.8
January ...	2.0	1.8	6.2	9.1	20.2	2.6	—	17.6	50.8
February ...	0.3	0.1	2.9	1.0	—	0.9	—	6.4	—
March ...	—	0.1	—	—	0.6	0.4	—	6.1	—
April ...	—	—	—	—	—	0.4	—	0.9	8.7

1. Elevation—
   Lowland :—Ngeme, Missellele, AFC, Holtforth, Likomba.
   Upland :—Molyko, Ekona.
   Kumba :—KKC, DWH.
2. Age of Cacao—
   Old :—Missellele, Holtforth, Molyko, Ekona, KKC, Ngeme.
   Young :—AFC, Likomba, DWH.

Tiko and Victoria districts, the main crop tends to ripen earlier in the year. Near the coast, the young cacao of the AFC and Likomba plantations is in full bearing between September and January, whilst the old cacao of Missellele, Holtforth and Ngeme produces a main crop which is spread over the period July to December. Molyko plantation contains mostly old cacao growing at elevations between 1,300 and 2,000 feet, and the main crop appears between July and September. The chief cacao area of Ekona plantation adjoins Molyko, is of similar age and in like manner has an early main crop. There is no recorded young cacao yet in bearing at these higher elevations.

In Figures 1 and 2, the monthly percentages of the total crop production are shown in graph form for three old and three young plantations. Of the old cacao in the Tiko area Missellele, at sea level, bears later than Molyko, at 2,000 feet, whilst the KKC in the Kumba area is later still. Of the young cacao, the DWH, in the Kumba area, is later than AFC and Likomba, both of which are at Tiko.

There thus appear to be three distinct cropping periods for these plantations; November to January in the Kumba district, July to December on the coast at Tiko and Victoria, and July to September up the slopes of the Cameroons Mountain. Furthermore, if the main crops of the KKC and the DWH, or the AFC, Likomba, Missellele and Holtforth plantations are compared, there would seem to be some foundation for the German claim that in any one area old cacao gave a crop earlier in the season than young cacao.

Yields.

The following figures give the average yield of dry cacao per acre per annum:—

Old Cacao.		*Young Cacao.*	
WAPV	.. 214 lbs.	AFC	.. 53 lbs.
KKC	.. 371 ,,	DWH	.. 54 ,,
Ekona	.. 304 ,,	Likomba	.. 49 ,,
Moliwe	.. 100 ,,	KEG	.. 28 ,,
Holtforth	.. 80 ,,		
Idenau	.. 107 ,,		

These figures are calculated on total production and total area under cultivation, and include those fields interplanted with rubber, oil palms or bananas.

These poor yields are due to a number of factors. The type of cacao grown (Forastero) is notorious for poor yielding capacity owing to the presence of self-incompatible types. Numbers of trees can be seen in these plantations which continue flowering profusely most of the year, and bear none or very few pods. In the old cacao fields many trees have the large girth and over-developed cushions which are typical of non-fertility. Nearly half the acreage under cacao was planted before 1914; a great deal was originally interplanted with oil palms or rubber, and the stands are now very far from being complete. In plantations like the KEG, the cacao has all been planted through bananas since 1930, and this practice has a marked retarding effect on the development of the trees because every attention is given to the bananas so long as they are producing economic crops.

It should be remembered that these yield figures include all grades of cacao produced. The bulk of the WAPV cacao came from Molyko where 80 per cent. of the crop ripens between July and September, when from 40 per cent. to 80 per cent. is suitable only for making into Black Cacao. Even the figure of 371 lbs. per acre for the KKC plantation includes proportions of 301 lbs. and 70 lbs. of Grade I and Black Cacao respectively.

It is notable that the yields for the young cacao farms are extraordinarily low, in contrast to experience in other countries. The bulk of the young cacao now in bearing would have been planted between 1925 and 1935 and could now be expected to surpass the yields of the old cacao farms. While there is no experimental proof, we are of the opinion that these low yields are due to a very slow development of young cacao in the Cameroons. This slow development, we believe, is caused by two factors, firstly the practice of interplanting cacao through other permanent crops or through bananas to take over when the latter cease to be profitable, and secondly the effect of the local environment which, as already mentioned, appears generally not to suit cacao. In these conditions, the inherently low yielding Forastero seems to surpass itself.

Processing of Cured Cacao.

Practically all the plantation cacao was sent to Germany. Three grades were usually produced for this purpose, Grade I, Black Cacao and Siftings (exported only under special licence).

(i) *Grade I Cacao.*—Germany apparently required a fermented cacao which did not have any bitter taste. It seems also that the German planters had been informed by their experts that during fermentation the temperature in the heaps of wet cacao should never rise above 40°C. To obtain the desired product, therefore, the general procedure was to change the wet cacao every twelve hours and to carry on fermentation for from ten to twelve days. As explained by Knapp (4,p. 107) this length of time was supposed to allow for the disappearance of the acetic acid through oxidation by micro-organisms, but the process had to be stopped before the undesirable butyric acid fermentation set in. The fermented beans were dried by artificial heat, the process generally taking four days. This plantation Grade I cacao was of good appearance, but it sometimes showed the effects of too rapid drying and was certainly over-fermented, judged by British standards (Knapp. *loc. cit.* p. 109).

(ii) *Black Cacao.*—This was produced from the beans of diseased or dead pods by a process of steam heating, washing in water and artificial

drying, probably a modification of the Stevens process (Knapp. *loc. cit.* p. 125). The final product was very similar in appearance to ordinary Nigerian Grade III cacao. Its manufacture required considerable labour and mechanical equipment.

(iii) *Siftings.*—All broken, germinated or otherwise damaged beans were treated in a rotating machine which removed the shell, dirt, &c. The cleaned broken kernels were known as siftings and were shipped to Germany under this title.

Black Pod.

The incidence of Black Pod disease varies enormously on different plantations. In young cacao, such as on the AFC at Tiko, Black Pod is negligible whereas in the old cacao at Molyko the incidence runs as high as 80 per cent. The accepted explanation has been the heavy rainfall which is experienced in the Cameroons, but it now seems that the incidence of the disease is governed by a number of factors, including rainfall, elevation, time of crop delivery, and age of the trees. For convenience, we have used the German production figures for Black Cacao as an indication of the incidence of Black Pod.

(i) *Rainfall.*—Table 2 shows the monthly rainfall and monthly percentage of the crop manufactured into Black Cacao for the Ngeme, Molyko and Missellele sections of the WAPV. Ngeme, with a total rainfall of 161 inches, of which nearly 98 inches fall during the months of June, July and August, does not show an average higher than 37 per cent. of Black Cacao in any one month. At Molyko and Missellele, the figures run as high as 82 per cent. and 52 per cent. respectively for Black Cacao produced, although the rainfall is from 50 to 70 inches less than at Ngeme. The German planters claimed that, as at Ngeme, Black Pod was much less severe in plantations along the west coast, where the rainfall is as high as 380 inches. On the other hand, the higher general incidence of Black Pod in the Cameroons as compared with the south-western provinces of Nigeria is almost certainly due to the extra 50 to 100 inches which the former receives.

(ii) *Elevation.*—As already mentioned, the WAPV has a series of small farms amongst the foot hills between Victoria and Tole, which is about 2,000 feet up. These farms contain mixed cacao and oil palms planted before 1914. In Table 3 are shown the percentages of Black Cacao produced from each of these farms, expressed as an average over eleven years. From Ngeme to Buana which are at low elevations round Victoria, the figures range from 14 per cent. to 21 per cent. Beyond this point the elevation increases rapidly and, notably round Sachsenhof, belts of mist are of common occurrence. As will be seen, the amount of Black Cacao rises from 41 per cent. to 56 per cent. of the total crop.

Referring again to Tables 2 and 3, the very high percentages of Black Cacao production shown at Molyko and Ekona (82 per cent. and 70 per cent.) are probably aggravated by conditions associated with elevations of 1,200 feet and over.

(iii) *Time of Main Crop Delivery.*—There does not seem to be a general correlation between Black Pod and crop delivery, although in some plantations the peak of main crop delivery does coincide with that for production of Black Cacao. This is the case at Molyko, where 80 per cent. of the crop is produced between July and September, and from 42 per cent. to 82 per cent. is Black Cacao. In a plantation like Missellele 47 per cent. of the crop ripens during the worst Black Pod months and 49 per cent. just afterwards, whilst for the KKC the figures are 45 per cent. and 53 per cent. respectively. In both these cases the main crop production peak is slightly later than that for Black Cacao. On the other hand, at Ekona 73 per cent. of the crop seems to ripen in July and August, thus avoiding the heavy incidence of disease which occurs in September and October.

(iv) *Age of Cacao.*—The age of the cacao trees seems to be one of the most important factors affecting the incidence of Black Pod. The young cacao of the AFC and the DWH can be compared with the old cacao of Missellele and the KKC respectively, as growing under similar conditions in the same localities. In both cases the young cacao suffers hardly at all from Black Pod, whereas in the old cacao the percentage of Black Cacao can be as high as 40 per cent. to 50 per cent. of the total crop in any one month. Whether the same thing would apply in the higher elevations is not known because two young cacao farms, at Tole and Molyko, have not yet come into bearing.

From these observations it seems that the incidence of Black Pod is governed by a complex of factors, of which age of the cacao is probably the most important. Generally speaking, Black Pod, is most common during the height of the rains. Old cacao seems to bear its main crop during this period. Old cacao trees, moreover, are generally full of cankers in the trunks and branches, and these provide sources of infection for the crop that is borne during that part of the year when conditions most favour the disease. The thick covering of moss on trunks and branches must considerably aggravate this state of affairs. Young cacao, itself largely free from primary sources of infection, further avoids the disease by producing the main crop later in the season when conditions are becoming drier.

Black Pod is reputed to have been far less serious in the cacao plantations before 1914, and it is possible that this was due to the cacao, being then in its prime, delivering a crop later in the season and from healthy trees.

TABLE II.—CACAO: COMPARISON BETWEEN DELIVERY OF CROP, % BLACK CACAO AND MONTHLY RAINFALL.

Month.	Ngeme.			Molyko.			Missellele.		
	Monthly percentage of Crop.	Black Cacao percentage.	Rainfall ins.	Monthly percentage of Crop.	Black Cacao percentage.	Rainfall ins.	Monthly percentage of Crop.	Black Cacao percentage.	Rainfall ins.
January ...	2.0	—	1.2	2.6	—	0.8	1.8	0.4	0.6
February ...	0.3	—	3.8	0.9	—	1.6	0.1	—	1.4
March ...	—	—	5.3	0.4	—	6.0	0.1	—	4.1
April ...	—	—	6.9	0.4	—	7.4	—	—	6.3
May ...	1.7	—	11.5	1.4	5.7	6.9	0.2	—	7.1
June ...	7.2	1.2	27.1	7.8	29.4	12.5	1.4	12.1	14.5
July ...	13.4	20.0	40.1	29.7	41.6	16.1	3.5	51.8	15.9
August ...	22.8	36.9	30.7	34.7	66.7	22.9	15.9	50.7	18.8
September ...	18.4	23.0	17.3	16.1	82.2	17.6	27.7	55.1	9.4
October ...	16.1	6.7	10.2	2.1	34.9	10.7	27.1	19.1	9.4
November ...	12.4	9.0	4.6	1.9	4.1	6.7	15.9	4.4	3.1
December ...	5.7	—	2.7	2.0	—	1.5	6.3	0.7	0.8
	—	—	161.4	—	—	110.7	—	—	91.4

1. Figures for percentage Black Cacao based on 11 year average: 1928-38.
2. Rainfall—Ngeme: Average 1931-38.
   Molyko: ,, 1928-38.
   Missellele: ,, 1928-34.
   ,, 1936-37.

TABLE III.

Month.	Ekona.		KKC.	
	Monthly percentage of Crop.	Black Cacao percentage.	Monthly percentage of Crop.	Black Cacao percentage.
January	—	—	17.6	2.3
February	—	—	6.4	3.6
March	—	—	6.1	1.2
April	—	—	0.9	—
May	—	—	—	—
June	—	—	1.1	6.0
July	18.2	20.9	—	—
August	55.1	13.4	2.3	24.2
September	13.0	70.4	3.5	43.5
October	12.5	73.3	9.9	41.9
November	—	—	29.6	33.7
December	1.2	—	22.6	8.1

TABLE IV.

WAPV—PERCENTAGE OF BLACK CACAO IN TOTAL CROP, AVERAGE OF 11 YEARS, FOR OLD CACAO FARMS SITUATED BETWEEN SEA LEVEL AND 2,000 FEET.

Farm.	Percentage of Black Cacao.	
Ngeme ...	15.6 %	(Sea Level)
Mokunda ...	21.1 %	
Krater ...	17.7 %	
Victoria ...	9.8 %	
Mittelfarm ...	15.0 %	
Limbe ...	13.7 %	
Bussumba ...	20.3 %	
Buana ...	16.6 %	
Ebongo ...	45.1 %	
Wotutu ...	41.4 %	
Sachsenhof ...	55.5 %	
Tole ...	48.5 %	(2,000 ft. elevation)

Plantation Experimental Work.

During the last ten years the German planters carried out a number of experiments, details of which are briefly noted here :—

(*a*) An attempt to discover high yielding trees resistant to Black Pod was initiated at WAPV in 1930. Yield records—including Black Pod percentage — on 5,440 trees were kept for two years. No use was made of these selected trees owing to a change of policy in that plantation. The labels on the trees have been lost and consequently no practical use can be made of the selection work. The figures so conscientiously obtained are however of some scientific value, and they have been published (5).

(*b*) At Ekona, the technique of budding cacao was well understood and rootstocks up to five years old had been successfully budded. The attempt to root cuttings had failed.

(*c*) Artificial manurial experiments at Ekona, using potash and phosphate, failed to reduce Black Pod disease.

(*d*) The same experiments failed to increase the yield of cacao.

(*e*) Spraying with Bordeaux Mixture reduced Black Pod disease, but was not economic. Apparently all estates in Fernando Po are religiously sprayed—even native holdings ; but this is apparently only made possible through the Spanish Government having fixed a subsidized price for cacao.

(*f*) Sahlbergella attack—rarely so severe as in Nigeria— was controlled by hand picking and occasionally by fire. It was thought that Sahlbergella attack fluctuated from year to year and would not be really serious even if no control measures were adopted.

(*g*) At Molyko and Tole, shade tree experiments have been planted using a large number of local and introduced species of Immortel, Albizzia and Cassia. The fields are as yet too young for deductions to be drawn.

(*h*) At the KKC attempts had been made to supply vacancies in some old cacao fields. Bananas, plantains, and *Leucena glauca* were used to give side shade and the cacao seed was sown at stake. These experiments were not successful.

Comparison of Cameroons and Trinidad Cacao Industries.

There is a marked similarity between the cacao industry in Trinidad and in the plantation areas of the Cameroons. The type of cacao grown in both is Forastero now known to be a low yielding variety but producing a quality of cacao superior to that of West Africa and Brazil (Leiocarpa species). Methods of cultivation are similar too, though the Immortel shade trees invariably used throughout the cacao fields in Trinidad have their substitutes in oil palms, rubber or nothing at all in the Cameroons. Both countries are faced with the same problem of how to make the industry pay, and in this respect Professor Shephard's intensive studies (6) on the economics of cacao cultivation in Trinidad have a direct bearing on the management of plantations in the Cameroons.

Shephard showed conclusively that the deciding factor in running an estate at a profit or loss was yield per acre. At the average price ruling between 1930 and 1935, estates whose average yield was less than 300 lbs. per acre ran at a loss, those of a higher yield at a profit, and this in the main was true irrespective of the inevitable variations in costs of production between estates. He showed that yield was directly influenced by type of soil and age of trees, fields between 15-25 years being the most productive. Later work (7) has shown that the variety of cacao grown is of equal importance in determining yield. The simplicity of Shephard's recommendations for individual estates are such that few managers welcome them, but we are convinced he is correct. His main theme is this :—

(*a*) Cut out and replace with some other crop all cacao fields over 25 years old the yield of which is below 300 lbs. per acre. If it is known that the soil is good for cacao (and experience is the best judge of this), the old trees may be replaced by young ones obtained from selected material. In Trinidad, sugar cane, citrus and tonka beans are the most usual substitute in old cacao land.

(*b*) Concentrate on fields yielding over 300 lbs. per acre and gradually replace the individual poor yielding trees (of which the best fields have over 25 per cent.) with selected plants. As the average yield for all Trinidad is only 210 lbs. per acre, his recommendations, if put into effect, would reduce the acreage under cacao enormously, but the industry would at last be put on a sound economic basis.

If the principles advocated by Shephard are applied to cacao cultivation in the Cameroons plantations, the following conclusions become inevitable :—

(i) The old cacao areas, situated in an environment obviously not really suited to the crop, have passed the age of economic production, if indeed they ever paid their way at all. Under British control the old areas have either been abandoned or replanted with other crops.

(ii) The old cacao of the KKC, from 26 to 33 years old, does just reach the minimum production standard recommended by Shephard. This is more particularly surprising because the yields are calculated for the total cacao acreage, including fields which have many vacancies and fields interplanted with rubber. It suggests that some fields must still yield well and that in this area cacao cultivation can be economically sound.

(iii) Until the young cacao farms at Tole and Molyko come into bearing it must be assumed that cacao cultivation is not suited to the lower slopes of the Mountains because the incidence of Black Pod is high and the crop delivered during the period when the disease is most destructive. Cacao should probably be confined to the Tiko plain, the Kumba area and the Meme River.

(iv) The German policy, in a number of the plantations, of interplanting cacao through bananas on orders from Berlin was not sound agricultural practice. In some instances, the conditions were obviously unsuited for cacao, and in others the conditions were equally so obviously ideal for bananas that no mixed cropping should have been tolerated.

(v) As in Trinidad, unselected Forastero is not the ideal cacao to grow in the Cameroons.

Present Position.

Selected Planting Material.

By good fortune, introductions of Criollo cacao had been made from Fernando Po by the KKC and Ekona. Small plots of these are now in bearing. We examined the trees in both plots and decided that the Ekona introductions, which were made as budwood, were poor and not worth further propagation, but the KKC plot, grown from seed, undoubtedly includes several very valuable trees capable of producing fine cacao. These trees have now been carefully checked for self-compatibility, and, self-pollinated pods from the selected trees have been examined. Whilst no tree was found to give pods containing only pure white Criollo beans, some do produce a fairly high proportion in each pod. The British Management now proposes that such white seeds, discovered by cutting the tips off the beans will be planted in a suitable area. From the resulting plants a supply of budwood will become available. In the existing blocks of old cacao at the KKC, the trees will be cut down to near ground level and the resulting chupons budded in due course. Vacant stands will be supplied with ordinary seedlings for budding as well.

Soil Fertility.

There is little doubt that the soil fertility of fields under pure cacao deteriorates. After about 15 years, it is often found impossible to establish young cacao plants in those gaps where, for one reason or another, trees have died. The exact cause of this difficulty in re-establishment is presumed to be soil deterioration brought about by exposure. Until more is known, it is safe to assume that shade trees would mitigate this effect. We therefore consider that it would be beneficial to establish shade trees through cacao fields still in cultivation, even if this resulted—as it probably would—in slightly reduced yield. Artificial manures have been used with financial success on certain soil types in Trinidad, but by no means so on all cacao estates in that island. As previously mentioned, the Ekona artificial manurial trials gave negative results, so with an absence of even cattle dung (the back-bone of the cacao industry in Grenada) the only means available in the Cameroons to maintain soil fertility is the use of shade trees. This conclusion had already been reached by the WAPV and AFC who in the past few years had been interplanting their young cacao fields with shade trees.

Cultural Operations.

In order to reduce production costs the British Management has decided to limit cultural operations to brushings twice only each year, one in April during the early rains, and the other in August prior to the main harvest, and to pruning reduced to a minimum. No Black Cacao has been produced since the outbreak of war.

Alternative crops.

As regards the crops to replace cacao, in many areas bananas, rubber or oil palms are known to do well. In other areas, where the conditions are peculiar, other crops will have to be used—a question outside the scope of this paper.

Acknowledgment.

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NATURAL POLLINATION OF COCOA, *THEOBROMA LEIOCARPA*, ON THE GOLD COAST.

By A. F. Posnette.

(*Botanist, Department of Agriculture, Gold Coast.*)

[*N.B.—The following article was written before Mr. D. J. Billes' article on the "Pollination of Theobroma Cacao* L. *in Trinidad, B.W.I." which was published in Vol. XVIII, No.* 8, 1941 *of this Journal. The delay in the publication of the present paper by Mr. Posnette was du. to the first copy, which was despatched from the Gold Coast in April,* 1941, *being lost in the maile The second copy did not reach us until the* 25*th November,* 1941.—Editor.]

The discovery of self-sterility in 1931 (4) and consequently of the necessity for cross-pollination between a large proportion of cacao trees in Trinidad, stimulated interest in the mechanism by which pollination is effected. Pound (5), Cope (1), Voelcker (7, 8) and Posnette (6) have each concluded that insects are essential for normal pollination; Dutch workers (3), on the other hand, consider wind to be of more importance in the East Indies. In West Africa self-sterility is so uncommon that cross-pollinating agents are of little importance in practical cocoa farming. Only Hewison and Ababio (2) paid them any attention until selection and breeding work was started, in which a simple method is needed to ensure controlled pollination on a large scale. Practical aspects would become important if the use of insecticidal sprays should increase, as is likely for the control of swollen-shoot virus disease and of capsid pests.

Table I.

Weekly Totals for 64 scattered trees 1938-39.

High Flowering Periods.				Low Flowering Periods.			
Week ending	No. of flowers.	No. pollinated.	Per cent.	Week ending	No. of flowers.	No. pollinated.	Per cent.
1938							
May 15 ...	2,218	226	10	Aug. 14 ...	154	22	14
22 ...	2,110	159	8	21 ...	30	14	47
29 ...	1,366	121	9	28 ...	6	1	17
June 5 ...	1,333	132	10	Sept. 4 ...	—	—	—
12 ...	789	162	21	11 ...	1	—	0
19 ...	1,354	127	9	18 ...	—	—	—
26 ...	921	142	15	25 ...	—	—	—
July 3 ...	856	111	13	Oct. 2 ...	—	—	—
10 ...	627	87	14	9 ...	2	2	100
17 ...	773	44	6	16 ...	—	—	—
24 ...	975	78	8	23 ...	4	2	50
31 ...	922	83	9	30 ...	1	—	0
Aug. 7 ...	422	88	21	Nov. 6 ...	—	—	—
Total ...	14,666	1,560	10.6	Total ...	198	41	20.7
1939							
Feb. 12 ...	15	7	47	Nov. 13 ...	1	—	0
19 ...	11	9	82	20 ...	—	—	—
26 ...	20	7	35	27 ...	3	3	100
Mar. 5 ...	32	12	38	Dec. 4 ...	2	2	100
12 ...	29	21	72	11 ...	2	1	50
19 ...	68	8	41	18 ...	2	2	100
26 ...	435	214	50	25 ...	4	4	100
Apr. 2 ...	562	275	49	Jan. 2 ...	9	8	89
9 ...	597	159	27	9 ...	9	5	56
16 ...	322	204	63	16 ...	16	14	88
23 ...	382	184	48	23 ...	9	7	78
30 ...	342	195	57	30 ...	6	3	50
May 7 ...	468	171	37	Feb. 6 ...	12	9	75
Total ...	3,283	1,486	45.3	Total ...	75	58	77.3
Year Total ...	18,222	3,145	17.3				

Observations on pollination made at the Central Cocoa Research Station, Tafo, for three years fall naturally into three sections. During 1938/39 (April-March), the incidence of pollination over the 60 acres of station cocoa was obtained by flower counts on 64 scattered trees of pure *Theobroma leiocarpa*. During 1939/40, the pollination on eight control trees was compared with that on six grease-banded and on six caged trees, detailed observations being taken on the insect population in the cages. During 1940/41, trials were made with insects suspected of pollination during 1939, using the caged and banded trees.

All trees in the investigation were first tested and proved to be fully self-compatible. Newly-opened flowers were counted daily; any flowers remaining on the tree four days and showing ovarian growth were labelled as pollinated. A longer period on the tree would not include pollinated flowers which fail to "set" for various reasons.

Season 1938-39.

Material: 64 scattered trees 19-20 years old.

It was found that the percentage of flowers pollinated was much greater when flowering was sparse. The weekly totals in Table I are therefore grouped in three-monthly periods of high and low flowering. During the profuse flowering period (May-August), variation in percentage of flowers pollinated was high (both tree-to-tree and week-to-week) though it is noticeable that the variation in number of pollinations is much less than that in the number of flowers. It appears that the insect population causing pollination determines the number, rather than the percentage, of flowers setting, and so may limit the amount of pod setting more often than does flowering. During the low flowering period (August-February), the consistently high percentage pollination indicates that the number of flowers produced does not exceed the capabilities of the pollinating insect. This efficient pollination when few flowers are open would not be expected if the flowers are anemophilous.

Table II.

WEEKLY TOTALS FOR EIGHT CONTROL TREES, 1939-40.

High Flowering Periods.				Low Flowering Periods.			
Week ending	No. of flowers.	No. pollinated.	Per cent.	Week ending	No. of flowers.	No. pollinated.	Per cent
1939							
May 28 ...	333	82	25	Aug. 27 ...	67	18	27
June 4 ...	256	76	30	Sept. 3 ...	60	18	30
11 ...	202	34	17	10 ...	33	23	70
18 ...	139	33	24	17 ...	6	5	83
25 ...	98	41	42	24 ...	20	5	25
July 2 ...	113	46	41	Oct. 1 ...	14	9	64
9 ...	75	30	40	8 ...	3	3	100
16 ...	167	73	44	15 ...	11	—	—
23 ...	256	95	37	22 ...	6	1	50
30 ...	201	92	46	29 ...	1	3	100
Aug. 6 ...	162	59	36	Nov. 5 ...	10	9	90
13 ...	120	60	50	12 ...	9	7	78
20 ...	70	43	61	19 ...	10	5	50
Total ...	2,192	764	34.8	Total ...	250	106	42.4
1940							
Feb. 25 ...	29	2	7	Nov. 26 ...	9	2	22
Mar. 3 ...	11	2	2	Dec. 3 ...	5	4	80
10 ...	12	0	0	10 ...	8	6	75
17 ...	135	0	0	17 ...	12	4	33
24 ...	52	2	4	24 ...	16	12	75
31 ...	63	0	0	31 ...	16	8	50
				1940			
				Jan. 7 ...	10	7	70
				14 ...	8	3	38
				21 ...	10	5	50
				28 ...	23	4	17
				Feb. 4 ...	20	8	40
				11 ...	23	7	30
				18 ...	20	3	15
Total ...	302	6	2.0	Total ...	180	73	40.6
Year Total ...	2,942	949	32.5				

Season—1939-40.

Material: 6 caged trees, 6 banded trees, 8 control trees } 10 years old.

Pairs of cages were constructed of three degrees of mesh :—baft cloth (calico) to exclude all insects, muslin to exclude all but thrips and aphids, and mosquito netting (coarsest mesh) to exclude only the larger flying insects. Crawling insects were excluded from the cages and from six uncaged trees by sticky bands. These were not satisfactory against ants, and concrete channels sunk six inches in the ground and containing oil, were added. Eight neighbouring trees were used as controls.

Flower counts on these *control trees* (Table II) gave results which, though showing an even higher pollination percentage, have similar characteristics to those of the 64 trees. The variation between trees is much less, and it is evident that weeks with a low pollination percentage are accounted for by a predominance of flowers on low-setting trees, especially during the sparse flowering period. However, it is difficult to disentangle the setting qualities of particular weeks or of particular trees. To what extent the higher percentage pollination of the control trees in the main flowering season of 1939 (compared with that of the 64 trees in 1938) is due to their difference in time or in situation, is indicated by the increased pollination percentage of the 64 trees during February-March, 1939, suggesting large seasonal variations in insect populations. Failure to record pollination during March, 1940, was possibly due to climatic factors affecting abscission, as hand pollination also gave comparatively poor results then, relative humidities being frequently below 60 at 3 p.m.

Table III.

Control Tree No.	May, 1939-Mar., 1940 [Year's Flowering].			May-Oct., 1940 [Heavy Flowering Period only].				
	No. of flowers.	No. poll'd.	Per cent. poll'd.	No. of flowers.	No. poll'd.	Per cent. poll'd.	Flowering weeks with pollination.	Flowering weeks without pollination.
3 ...	541	132	24.4	383	65	17.0	16	7
4 ...	645	232	36.0	277	57	20.6	14	9
11 ...	301	106	35.9	571	101	17.7	15	3
20 ...	136	48	35.3	189	31	16.4	8	2
21 ...	337	111	33.0	674	65	9.6	21	4
170 ...	224	88	39.3	420	45	10.7	13	4
172 ...	319	97	30.4	849	112	13.2	13	5
180 ...	421	133	31.6	532	79	14.8	14	4
Total ...	2,924	947	32.38	3,895	555	14.2	114	38
Banded								*Ant No.*
41 ...	61	15	24.6	40	4	10	3	10 } 1314
49 ...	35	10	28.6	12	—	—	—	6
72 ...	20	7	35.0	107	43	40.2	7	1 } 1267
138 ...	333	116	34.9	462	97	21.0	15	7
68 ...	38	10	26.3	76	14	18.4	5	8 1281
47 ...	62	15	24.3	94	15	15.9	7	12 None
Total ...	549	173	31.51	791	173	—	37	44
Caged.								
Muslin Cages 93 ...	279	3	1.075	140	1	.7	1	8 } 1281
Cages 19 ...	717	6	0.84	434	4	.9	3	13
Mosquito Netting 150 ...	522	32	6.13	129	—	—	—	13
Netting 43 ...	325	11	3.38	432	5	1.0	4	11 } 1338 & 1346
Baft 25 ...	1,438	9	0.01	120	—	—	—	8 } No ants
Cloth 59 ...	69	—	0.00	24	—	—	—	7
122 New	wire	gauze	cage	44	1	2.3	1	8 1281
57 New	wire	gauze	cage	153	3	2.0	3	7 1296
Total ...	3,350	61	—	1,476	14	—	12	75

Identification by Imperial Institute of Entomology.
No. 1267 *Crematogaster* [*Sphaerocrema*] sp.
1296 *Crematogaster* [*Acrocoelia*] sp.
1281 *Pheidole* sp.
1314 *Camponotus* sp.

The behaviour of banded trees can be judged from Table III. It was found impossible to exclude ants completely, but their numbers were drastically reduced for considerable periods on most trees. Those trees which carried an ant population (species No. 1267) most of the time, Nos. 138 and 72, had about the same pollination percentage for the year as controls, but the reduction of ants on other trees reduced pollination. The manner of the reduction is shown in Table IV; compared with controls, banded trees have a much greater proportion of weeks with flowers remaining unpollinated, so that when pollination did occur, it must have been exceptionally efficient to bring the total percentage up to control level.

The importance of ants must be stressed again in connection with the pollination in the cages shown in Table IV. The Entomologist took a weekly insect census in each cage, and weeks with "sets" were always associated with ants penetrating the cage. No other insects found inside the cage were associated with setting, although aphids (*Toxoptera aurantii*), psyllids (*Mesohomotoma tesmanni*) and thrips (*Heliothrips rubrocinctus*) were usually present. The ants suspected of pollination were more frequently found in mosquito netting cages than in muslin or baft. As is shown in Table IV, muslin and baft cages behaved alike in frequency of setting, but mosquito netting is significantly different. A gradation in frequency of pollination according to the degree of insulation from insects is shown in Table IV.

Table IV.

FREQUENCY OF POLLINATION AND DEGREE OF INSULATION FROM INSECTS.

	No. of weeks when trees flowered.		
	With Pollination.	Without Pollination.	Total.
Controls ...	183	56	239 $X^2=164.26$
Banded ...	75	62	137 f =3
Cages—			
Mosquito N.	23	44	67 sig. at 0.1%
Muslin and Baft	13	119	132
	294	281	575

Season 1940-41.

Material: as previous year.

At the beginning of the profuse flowering period in May, 1940 it was decided to test the relative efficiency of the ants which had been associated with the trees during the previous year. Few of these ants could be identified on the Gold Coast and pending identifications by the Imperial Institute of Entomology, they were known by reference numbers (given in the right hand column of Table III). The testing was done by establishing a "pure culture" of the desired ant on the particular tree, which was either caged, or isolated by a concrete channel (the grease-bands had been abandoned by this time). These channels enclosed a circular patch of soil about 2 ft. in diameter round the base of the tree so that terrestrial species could nest underground. Two baft cages and one banded tree were kept free of ants for controls, together with eight control trees from which insects were not excluded in any way.

The results of daily flower and pollination counts are given in Table III and should be compared with the previous season's figures given in the same Table. The big surprise was the failure of Ant No. 1281 to do any pollination on four caged trees; this ant commonly attends aphids on the peduncles of cocoa flowers. Ant 1314, also an aphid tender was ineffective, but this ant is too big to extract pollen easily from inside the petal-hoods. Ants 1338 and 1346 were shown also to be non-pollinators, whereas 1267 was very effective.

Efficient pollination by Ant 1267 is illustrated by Table V, showing the association of the respective ants with weeks when the tree flowered with, and without, any pollination occurring. The difference is significant only because of 1267; differences between the other ants are not significant; trees with any other species of ant behaved just like the trees from which all ants were excluded ($X^2c=0.34$)*. On the contrary, trees with No. 1267 behaved like control trees open to all insects ($X^2c=0.18$); these eight control trees are uniform as regards frequency of pollination ($X^2=4.86, f=7$).

Table V.

Ant No.	Flowering weeks. With pollination.	Flowering weeks. Without pollination.	Total.
1267 ...	22	8	30
1314 ...	3	16	19
1296, 1338, 1346 ...	7	18	25
1281 ...	10	50	60
Total ...	42	92	134

$X^2=32.85, f=3.$ Sig. at 0.1%.

Similar analyses on the number of flowers pollinated also show that the ants other than No. 1267 have no effect whatever on pollination. They failed to increase percentage pollination with the previous season, or to cause any significant difference between trees inhabited by different species.

The 18 per cent. pollination observed on banded tree No. 68 with the ineffective Ant 1281, and the 15 per cent. on tree 47 with no ants, must be due either to flying insects or to wind. It is possible

* In this paper, X^2=chi-squared.

that wind could cause self-pollination, but so little pollen is produced that it is difficult to attribute cross-pollination to wind. It appears necessary to postulate a flying insect as responsible not only for the setting on isolated self-sterile trees (cross-pollination over at least 20 yards was recorded at Aburi) but also the 27 per cent. pollination of emasculated flowers (Table VI).

Table VI.

Treatment.	No. flowers.	No. Cross pollinated.	Per cent.
Emasculated ...	90	30	33
Control ...	13	4	31
Emasculated ...	45	11	24
Control ...	50	22	44
Emasculated ...	39	7	18
Control ...	38	15	39

The most probable flying insect which could have escaped notice so far is some species of Thrips. The possibility of a night flying pollinator was tested by covering flowers for different periods. The figures given in Table VII indicate that most flowers are pollinated between 9 a.m. and 5 p.m. on the day they open; no pollination occurred outside these hours, and the highest percentage took place in the afternoon.

Table VII.

Treatment.	No. of flowers.	No. pollinated.	Per cent.
Covered 9 a.m. onwards ...	50	0	0
Exposed 5 p.m. onwards ...	12	0	0
Covered 2 p.m. onwards ...	28	4	14
Exposed 7 a.m. to noon ...	40	3	8
Exposed noon to 5 p.m. ...	10	4	40
Controls ...	125	32	25.6

Trinidad cocoa research workers, used to less than 5 per cent. pollination, will be surprised, no doubt, at the high percentage pollination recorded in this paper. The difference in the cocoa, *Theobroma leiocarpa*, as opposed to Trinitario hybrids, might be the explanation; or it may be due to the pollinating agents being different. The introduction of parasites is now a well-established practice, but the introduction of less specialised insects involves so many possible complications that it is unlikely to be given serious consideration.

These investigations are being continued with the object of ascertaining the exact efficiency of *Crematogaster* (*Sphaerocrema*) sp., No. 1267 and of discovering other pollinating ants and the flying agent.

Summary and Conclusions.

1. All the evidence of three-year investigation confirms that insects are the pollinating agents of cocoa on the Gold Coast.

2. In the profuse flowering period, about 10 per cent. of the flowers are pollinated, the number pollinated being more dependent on the insect population than on the number of flowers.

3. In the low flowering periods, insects are able to visit nearly all the flowers; during 13 weeks (Nov. 7 to Feb. 5), 79 per cent. were pollinated on 64 trees.

4. By means of caged and banded trees, evidence was obtained that only one species of ant (out of five tried) caused pollination.

5. Considerable evidence is given that flying insects are responsible for a large proportion of natural pollination. Apparently, the flying pollinator is not nocturnal.

Acknowledgments.

The writer is indebted to Mr. G. S. Cotterell, Entomologist of the Department of Agriculture, for his helpful co-operation in designing these experiments and identifying the insects; also to Mr. R. Luddington for his valuable assistance with the statistical analyses. I have to thank Mr. H. B. Waters, Director of Agriculture, for permission to publish this paper.

I wish to record my appreciation of the efficient way in which Mr. L. Q. Reimmer, Laboratory Attendant, carried out the flower counts on which this paper is based.

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"MIXED FARMING" IN THE TROPICS: A DEFINITION OF THE TERM.

By O. T. Faulkner, C.M.G., B.A., Dip. Agric.
(*Principal, Imperial College of Tropical Agriculture*).

The term "mixed farming" frequently appears in literature about tropical and sub-tropical agriculture. It seems to be used with a variety of meanings. It may therefore be profitable to explain exactly what the term meant to those who (as we believe) first applied it to a system of farming in the tropics.

The Nigerian Agricultural Department first began to use this term in the Northern Provinces of that Colony in 1923 or 1924 in connection with a programme of field experiments that was then being initiated at its agricultural stations. The meaning, in which that Department (of which I was then head) employed the term, was somewhat different from the sense in which it is used in regard to English farming, or at all events from the sense in which it was used in the Midlands of England thirty years ago.

So far as we knew no one had ever defined very exactly what was meant by this term, even in regard to English agriculture. But in my home district, at all events, to say that a farm was a mixed farm conveyed to one's hearer at least two separate and not logically interdependent facts about that particular farm. To describe a farm as a mixed farm implied that it consisted of considerable proportions both of permanent grass and of arable land. But a second fact was equally definitely conveyed, namely that the basis of the manuring of the arable land was farmyard manure, made on the farm by cattle standing on straw bedding. A grass farm, whether the grass were used for sheep or dairying or what not, did not become a mixed farm merely because some ten per cent. or so of the land was under the plough, growing food for the stock. But neither was an arable farm a mixed farm if sheep-folding was the basis of the manuring of the arable land. Nor, I am sure, would one have described as "mixed" a farm (there were a few such here and there) on which practically no stock at all was kept, and from which everything, hay, straw and roots, as well as grain, was sold off, and where consequently the farmer relied for the maintenance of fertility on the purchase of artificials and of stable manure from the neighbouring town. Even if such a farm had consisted of 50 per cent. of meadow land and 50 per cent. arable, yet no one would have described it as a mixed farm: for it lacked the second essential feature, the making of farmyard manure by neat stock kept on bedding in the winter.

It was also undoubtedly a normal characteristic of a mixed farm that profit was made by the sale of animal products as well as by the sale of grain—profit that might be realized from milk, butter or cheese, by cattle rearing, or fattening, or from all of these. For if a farmer kept stock to make manure he naturally tried to make a profit from the stock. It was thus very nearly true to regard this as an essential feature of the English mixed farming system. Yet there were some farms with poor grass land and poor buildings but much arable land, where the stock keeping was reduced to its simplest and least profitable form, that of "running on" store cattle, purchased as yearlings or two-year olds, and sold again later still in store condition. Such a farm, provided it had a fair proportion of grass, was certainly regarded as a mixed farm, while, as already stated, a sheep-folding farm with little grass would be called simply an arable farm. And this in spite of the fact that animal products might well form a much more important item in the receipts of the sheep farm than of the other. Thus it seems that the farmyard manure making was as essential a feature of a mixed farm as the mixture of arable and grass land; but the sale of animal products, though more or less implicit in the term, was yet not quite one of its essential meanings.

We in Nigeria undoubtedly, and quite wittingly, partially misused this term when we adopted it locally: for we had then no concern whatever with permanent pastures or meadows, nor even with temporary leas. We were thinking only of one of the two essential characteristics of English mixed farming, namely, the maintenance of the fertility of arable land by the use of farmyard manure, consisting largely of bedding. The greater part of the farm would still be devoted to the production of food and cash crops.

The position in Northern Nigeria at that time was that almost all of the three million or so head of cattle that the country possessed were owned by the nomadic "Fulani", while the "Hausa" farmers, with unimportant exceptions, owned no cattle at all. The only connection between the two sections of the population was that when the farmers' harvest was over, the Fulani cattlemen, in return for certain payments in kind, would bring their cattle onto the farm lands for about four months to eat the stubbles of the crops and to manure the fields with their urine. The cattle dung was a comparatively unimportant factor in this manuring process, because even if it was not burnt, as was quite a common practice, it soon became converted into dust and much of it was eventually blown away: for the climate at that time of the year was both intensely dry and very windy. By this "cattle kraaling" as it was called departmentally, it was possible to maintain the fertility of land very satisfactorily, provided that one had enough cattle on it for a long enough time. But to maintain the fertility of all the fields of the country satisfactorily

by this means would have needed many times more cattle than the country supported. In practice only the rich could afford to have their land manured in this way; the ordinary peasants had to rely on shifting cultivation.

The Agricultural Department was desirous of introducing the use of cattle for ploughing the land and more especially for inter-cultivating the growing crops. For in most dstricts there was still land to spare, and it was reasoned that, if he had a pair of draught cattle, the ordinary farmer and his family could easily cultivate ten or twelve acres of crop instead of the three or four which was all that they could work with their hand hoes. Ploughing with cattle had already been successfully introduced in very similar circumstances in Uganda, with important results. Some earlier trials had also been made in Nigeria a few years before; and although those trials had revealed certain technical difficulties and had therefore been discontinued, yet they had shown that the difficulties were only such as might well be overcome with time and study. But it was very strongly felt by all concerned that, with the yield of crops in Northern Nigeria so low as they already were, and with even that low level of fertility maintained only by shifting cultivation, it would be a grave and fundamental error of policy deliberately to introduce the means of increasing the area under cultivation, unless and until some practicable means had been found for manuring the land. In this connection "practicable means," implied, *inter alia*, a means which native cultivators could and would readily adopt as soon as its value was effectively demonstrated.

Therefore the first step in the introduction of cattle cultivation in Northern Nigeria was not to import a plough, or to design a "horse-hoe" suitable for bullocks, but to obtain some very old and decrepit cows. This grade of animal was used in the first experiment because, on the basis of ideas current at the time in India and among the natives of Northern Nigeria, it was an open question whether cattle would maintain their health if they were kept on bedding in a pen, whether roofed or unroofed, and even if they were kept in it at night only. Our first object therefore was to ascertain by trial whether cattle could be so kept, and our second objective was to find out whether farmyard manure thus made was advantageous to crops in a very dry climate; or whether such manure would, as farmers in the driest parts of India and also in Northern Nigeria firmly believed, "burn up" the crops on which it was used. The experiment was one of a series of trials of various methods, including also green manuring and cattle folding, laid down in an attempt to study every likely way of maintaining the fertility of the land without having to resort to shifting cultivation.

The experiment at once showed that even distinctly "long" farmyard manure, under the particular conditions of that country, so far from "burning the crops", gave remarkably great increases in their yield, even when it was used at a relatively small rate per acre. Experience also soon showed that the by-products of ten acres of the ordinary crops of the country, when properly conserved, would go far towards maintaining a suitable head of stock for such an area. Thus was proved the fundamental soundness of the system of mixed farming that had been dimly envisaged when we obtained the old cows for the first experiment. Since then a complete mixed farming system suited to the conditions of the country has been, and is being, steadily elaborated. The first step in this elaboration of the system, once the value of the manure was proven, was to take a profit from cattle, by using bullocks for cultivation operations. The next step, following as quickly as circumstances permitted, was the introduction of cow keeping, milk selling and calf-rearing. Only recently, nearly fifteen years after the first trial with the old cows, have experiments been made to test the feasibility and desirability of including in the mixed farm a small proportion of grass, either permanent or rotational.

So detailed an account has been given of the introduction of mixed farming in Northern Nigeria in order to emphasise that the term then meant, not something about the proportions of arable and grass land, but only a farming system of which the basis was the manuring of arable land with farmyard manure made by keeping cattle at night on bedding. It was also of course implicit in the word that some of the land and manure should be devoted to the production of some grain, vegetable human food or saleable vegetable product. A farm of which the business was, for instance, only the sale of milk or beef, and the necessary feeding of the stock with grass or even cultivated and manured fodders, would be simply a dairy farm or a stock farm rather than a "mixed" farm.

It is suggested that this limited sense should be generally adopted as a defined meaning of the term "mixed farming" when it is used in respect to tropical and sub-tropical countries. For the essential weakness of the arable farming of those countries lies in the fact that the roughage and waste materials of the farm are normally wasted or burnt instead of being turned, as they should be, into farmyard manure—or into compost, if this latter product is anywhere more economical to make than farmyard manure. It must be admitted that it is hardly possible to conceive of a mixed farming system in this sense—that is one based upon farmyard manure—which is yet at the same time a one-crop system. But if that were possible, then it is suggested that in the tropics such a system might fairly be regarded as an unusual, but none the less genuine, kind of mixed farming.

Two systems of cultivation in the British West Indies are of interest as border-line cases. Sugar cultivation in those colonies is "one crop farming" in a very extreme degree. But it happens that sugar cane, with its tops and molasses by-products, and its grassy "traces" between fields, provides much cattle food. Further the estates still keep

cattle or buffaloes as well as mules for field transport, and by using trash as bedding in the animals' pens, make pen manure for the cane fields. Can this be called a kind of mixed farming ? It seems to the present writer hardly to come into that category, not because it is a one-crop system, but because the amount of pen manure made is small as compared to the area of the estate; and because, in consequence, the whole cultural system depends, not on farmyard manure, but upon artificial manures. If many more cattle were kept and the relative importance of pen manure and artificials in the farm economy were thus reversed, then, it is suggested, sugar-cane culture would be one form of mixed farming. But if that were done, it would be economically essential that the estate dairying, which is now an occasional small sideline, should be greatly developed ; and then it would almost certainly follow that some fodder crops would be grown especially for the cattle. The whole system would then be very different from what it is to-day. Whether it would be a more profitable system in the long run may be another question : but it would certainly be a very different system.

The cacao fields of Grenada have for long been regularly manured by a system in which cattle are tethered under the trees and bedded and fed with grass cut and carried from the estate's rough meadows. It is said that in this way dressings of as much as twenty tons of pen manure per acre at a time used regularly to be given to the cacao lands; and that the grass from as much as two acres of meadow would be used to keep up the fertility of three acres of cacao, by manuring three-quarters of an acre of cacao each year. Was that a system of mixed farming ? It seems to the present writer that it could quite accurately have been so called. It was unquestionably an unusual form of mixed farming, and by modern standards it was perhaps a crude system. For to use good land in the wet tropics as rough meadow meant getting only a fraction of the return that could have been got from it by cultivating such fodders as Guatemala grass or Elephant grass, let alone by any more elaborate system of arable farming. It would seem also that as much return was not got from the stock as might have been made by some more elaborate form of animal husbandry, such as dairying. But the fertility of the cacao land was permanently maintained at a very high level by the unroofed stall feeding of cattle and the conversion of much bedding into farmyard manure. For this reason it seems to the writer that that old system could fairly be called a system of mixed farming. Whether the same term can equally fairly be applied today, when the cattle are apparently tethered under the cacao trees only once in every ten or fifteen years and the yield of cacao is declining—that is another question, outside the scope of this note.

SOIL MULCH AND MOISTURE CONSERVATION.*

Formerly it was accepted without question that the loosening of the first few inches of surface soil by means of harrows or other implements was an aid to the conservation of the moisture in the lower soil. In spite of the fact that many findings during the past twenty years cast some doubt on the validity of this theory, there are still many farmers who believe in the effectiveness of a soil mulch in dry farming. The reason for this belief is partly due to the fact that the movement of moisture in the soil is not always correctly understood.

Capillary moisture such as appears in the soil can be divided into two types, *viz.* real capillary moisture and apparent capillary moisture. *Real capillary moisture* occurs in conjunction with underground water, *i.e.*, within two or three feet above the level of underground water. In this zone the typical capillary movement of the moisture can be detected and may be compared with that of paraffin in the wick of a lamp. This upward movement can be inhibited by breaking the capillary tubes. In practice, therefore, the loss of this moisture as a result of evaporation on the surface can be reduced by cultivation, *i.e.* by establishing a mulch. It seldom occurs, however, that the natural level of underground water is only three feet below the surface of the soil.

If dry soil is irrigated and it is found after a while that the soil is moist to a depth of four feet, those four feet of surface soil are said to be saturated to their "field water capacity". The movement of moisture to the drier subsoil takes place very slowly, since this type of moisture, which is also known as *apparent capillary moisture*, moves mainly in the form of vapour. The same applies to the movement of moisture from below, to surface soil already desiccated. A breakdown in the capillary tubes in the soil caused, for example, by cultivation, can therefore have only slight practical effect, if any, on the conservation of this form of moisture in the soil.

Recent experiments on heavy, clayey soil at the College of Agriculture, Glen, South Africa, have confirmed the conclusion reached from others on light, sandy soil, namely that cultivation is of much more value to a crop *as a means of controlling competing weeds* than as a means of maintaining a mulch for moisture conservation.

* Adapted in the *East African Agricultural Journal*, VII, No. 1, 1941, from an article by L. L. Eksteen and M. J. van der Spuy in *Farming in South Africa*, XVI, No. 179, 1941, p. 51.

DEATHS.

We regret to announce the deaths of the following past students of the College :

Mr. R. S. Ball (1932-33), Agricultural Officer, Kenya, who was killed in action in East Africa.

Mr. H. T. Measures (1937-38), Agricultural Officer, Kenya, who was killed in action in the Middle East.

Mr. A. B. Lucy (1936-37), Agricultural Officer, Malaya who died in Malaya from an attack of "Japanese River fever."

CHEMICAL NOTES.

(Compiled by the College Department of Chemistry and Soil Science.)

Emulsifiers for Insecticides.

Soap, cresol, albumin and casein, used as emulsifiers in petroleum insecticides, are equally effective in emulsifying the vegetable oils of the crop sprayed, and may cause dropping of leaf or bloom reduction in the fruit and other damage.

The inventor has discovered that the property of "selective emulsification" (*i.e.* being excellent emulsifiers of mineral oil but almost inactive towards vegetable oils in the concentrations used) appears to be conferred by the balance in the polar molecule between this oil and water-soluble portions. Selective emulsification has been found to be a particularly characteristic property of such balanced polar compounds, in which the water-soluble portion of the molecule consists of multiple ether groups. The condensation product of substantially equimolecular quantities of coconut oil, fatty acids and polyethylene glycols, of which triethylene or tetraethylene glycols have been found particularly effective, provides an emulsifying agent which fulfils the conditions. Any mixture of fatty acids consisting predominantly of lauric or myristic acids may be used.

Tests in which 5 per cent. of the emulsifier in oil was used and 2 per cent. of the combined emulsifier and oil and water, showed no emulsification of the vegetable oils, whereas the same concentration of the emulsifier with petroleum gave excellent emulsions.—J. W. Orelup—(*Manufacturing Chemist*, Vol. XII, 1941, p. 194.)

* * *

Mushroom Extract for Relieving High Blood Pressure.

Extraction of a substance from mushrooms, potatoes, and many other plant and animal tissues, which produced a significant reduction in high blood pressure in seventeen of the twenty patients on whom it was tried, was described by Dr. H. A. Schroeder of the Rockefeller Hospital, New York, to the American Society for Clinical Investigation. Doses of from 3 to 10 mg. daily were administered. This substance is tyrosinase, an enzyme which decomposes tyrosine. The tyrosinase is destroyed both by cooking and by the digestive juices of the stomach. It must be administered intravenously in order to obtain the beneficial effects.

Tyrosine is related chemically to adrenalin and other substances known to elevate blood pressure; it was on the theory that angiotonin, the factor causing blood pressure elevation, might be a member of this family that Dr. Schroeder tried the tyrosinase in the hope that it would break down the angiotonin in the same way that it breaks down tyrosine. — (*Manufacturing Chemist*, Vol. XII, 1941, p. 187.)

Coconut Shell Charcoal.

Coconut shell charcoal is one of the best absorbents for gases, &c., after it has undergone a process of activation. Estate charcoal as exported has very little absorbing power. Purchasers require a certain standard of quality and freedom from impurities that render activation more difficult. Common faults of a locally produced charcoal are:—excess of moisture, sand or earthy matter; insufficient burning; the inclusion of salt due to the use of brackish water in cooling off. The weight of charcoal, obtained if the proper technique is carried out, should be just under 30 per cent. of the weight of the original shells. The usual standard requirements are:—*Size*: Not more than 5 per cent. to pass a $\frac{1}{4}$ inch mesh sieve. *Ash content*: A limit of 2 per cent. Since clean charcoal averages 1.8 per cent of ash, this only leaves a tolerance of 2 parts per thousand for sand, &c. *Chloride content*: A limit of 1.0 mg. per gm. *Moisture*: From 5 to 10 per cent. according to specification of purchasing form. *Volatile matter*: Usually 15 per cent.; that is, that when heated under certain standard conditions the same shall not lose more than 15 per cent. of its weight. Should it do so it is an indication of the common fault of underburning. Pyroligneous acid and tar from the vapours given off by charcoal can be manufactured, but the process is not suitable for small estates.—(*Horticultural Abstract*, X, p. 310.)

* * *

Four Methods of Mothproofing.

At a temperature of 18° to 20°C., moths can be eliminated from textiles in less than a minute by carbon tetrachloride, trichloroethylene, perchloroethylene, &c.—C. H. Fischer, *Deut. Wollen-Gewerbe*, 72, pp. 952-3.

Exposure of garments to an equal mixture of ethylene dichloride and carbon tetrachloride in a concentration of 20 to 25 lbs. per 1,000 cubic feet of air for twenty-four hours at 65° to 75° F. will kill moth life.—F. W. L. Nelson, *Nat. Cleaner Dyer* (U. S.), 1941, 32, 3, p. 54.

About 5 per cent. of hexachlorethane, acetone, chloroform or chloral hydrate is used as an activating agent with mono-and dichlorobenzenes in moth-killing preparations.—H. von Philipp, U.S. Patent No. 2,214,782.

Fabrics are treated with an aqueous solution containing a complex salt of antimony and fluorine, such as ammonium fluoantimonate.—D. H. Jones, U. S. Patent No. 2,214,962.—(*Manufacturing Chemist*, Vol. XII, 1941, p. 187.)